

1388 1/2
66
A .
DISCOURSE

ON THE

TORPEDO,

DELIVERED AT THE

Anniversary Meeting of the ROYAL SOCIETY,

November 30, 1774.

By Sir JOHN PRINGLE, Baronet, *K*

PRESIDENT.

PUBLISHED BY THEIR ORDER.



LONDON:

Printed for the ROYAL SOCIETY.

MDCCLXXV.

D I S C O U R S E

E O R P E D O

DELIVERED AT THE
ANNUAL MEETING OF THE ROYAL SOCIETY

BY SIR JOHN H. BROWN,
PRESIDENT OF THE SOCIETY



PUBLISHED BY T. & A. CO. LTD.

LONDON

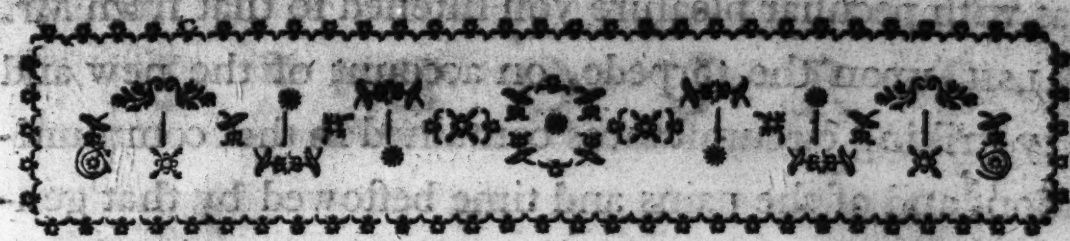
PRINTED FOR THE ROYAL SOCIETY

BY T. & A. CO. LTD.

LONDON

PRINTED FOR THE ROYAL SOCIETY

BY T. & A. CO. LTD.



GENTLEMEN,

THE disposal of the annual prize-medal, founded on the benefaction of sir GODFREY COPLEY, baronet, having for some years past devolved upon your President and Council, they have hitherto been fortunate in executing their trust in such a manner as to receive your approbation. Indeed, the strict regard for the honour of the Society, and the deference due to the opinions of the other learned members, have been so much the objects of their attention, that they could not well fail to be directed by them to such of your publications as were most deserving your favourable notice; and they flatter themselves, that they shall not now be less successful than on former occasions. For, if you call to mind the various Papers of experiments in the last volume of your Transactions, you may remember, that though you warmly acknowledged the merit of many of them, yet it

was with peculiar pleasure you listened to that from Mr. WALSH, upon the torpedo, on account of the new and very striking circumstances contained in that communication, and of the pains and time bestowed by that gentleman on this inquiry.

But, in order to your more freely sealing the choice of your Council with your suffrages, permit me, GENTLEMEN, first to lay before you a short abstract of what had been done in this branch of natural history, antecedent to Mr. WALSH's experiments; and then to remind you of a few of his principal ones, that while we do justice to our worthy brother, none may be defrauded of the praise due to their labour.

THE torpedo, or cramp-fish, a species of the ray, being a common inhabitant of the Mediterranean, was early known to the Greeks. We find it first mentioned in a book anciently ascribed to HIPPOCRATES, though only as an esculent fish; but the name alone (*νάρκη*) is sufficient to ascertain the knowledge the ancients then had of its torporific qualities. And PLATO, nearly contemporary with HIPPOCRATES, certainly knew of them, as
appears

appears by the humorous comparison he makes of SOCRATES to that animal, which he puts into the mouth of MENON, in his dialogue of that name. And his celebrated disciple in physics, ARISTOTLE, particularly treats of it in his History of Animals. The torpedo (says he) hides itself in the sand or ooze, and whilst the other fishes swim over it, and touch it, he benumbs them, so as to catch them and feed upon them: as a proof, the mullet, the swiftest of the watery race, is found in his stomach.

But though ARISTOTLE knew that the touch of the torpedo stupified other fishes, he seems not to have known that this extraordinary effect could be transmitted to other animals not in immediate contact with it, but by the interposition of a stick, a rope, or water; facts too curious to have been omitted had he ever heard of them. Possibly he might have been informed, but rejected the accounts as fabulous (for of all the ancients none appear to have been so much on their guard against imposition) or he might have thrown them into some part, that has been since lost, of his book called Θαυμάσια Ἀνέκδοτα, *Wonderful Relations*. Yet ARISTOTLE had only the testimony of fishermen for what he reports of the torpedo: indeed he expressly says so. In those days, and for many ages after, the pride of man set him above experiments; and
above

above the suspicion, that by such low and mechanical operations he was to discover causes and learn to reason. ARISTOTLE himself, that admirable genius, knew not this. Had the great Stagirite heard, that, to understand by what principles the torpedo acted, a naturalist from Britain had travelled through Gaul to the Atlantic ocean, and on that coast had made a hundred experiments upon that fish, and with success; there is no doubt he would have placed that account among the chief of his *Wonderful Relations*. Lord BACON was the first who detected and combated this presumptuous error, and who, by humbling the vanity of man, exalted his power over the works of nature. He was the first who taught, that as *our bread*, so our science was to be earned *by the sweat of our brow*; and the works of this society will, I trust, be an everlasting testimony of the truth of his doctrine.

THEOPHRASTUS, the learned scholar and successor of ARISTOTLE, appears to have been better informed concerning the torpedo than his master. ATHENÆUS relates, that this philosopher, in his book on venomous animals, observed that the torpedo conveyed this benumbing sensation through sticks and spears into the hands of the fishermen that held them. And since I have quoted ATHENÆUS, though not in a chronological order, I shall

add, that he mentions DIPHILUS of Laodicea, for taking notice, in his commentary upon the *Theriaca* of NICANDER, that it was not the whole, but certain parts of the body of the torpedo that occasioned the torpor. HERO of Alexandria, in his Pneumatics, mentions this fish as emitting effluvia through brass and iron and other solid bodies.

PLINY, the laborious and useful compiler of ancient natural science, too little a philosopher himself, and too great a lover of the marvellous, has treated this subject accordingly. Thus, he says, the power of the torpedo may be felt through the length of a rod or a spear, which is a fact: but that this fish binds the legs of the nimblest person that treads upon it, is an exaggeration; and that this animal is able to bind the arms of the strongest, at a distance, is false.

PLUTARCH, though no professed naturalist, yet furnishes us with a fuller and juster account of the torpedo. According to him, this creature not only benumbs all those that touch it, but also strikes a numbness through the net into the hands of the fishermen; nay, as some report, if it happen to be laid on the ground, alive, those that pour water upon it shall be sensible of some diminution of their feeling. Now whether this last fact has been confirmed by later experiments, I have not learnt, but

but I am inclined to believe it, as not inconsistent with Mr. WALSH's principles. PLUTARCH adds, that whilst the torpedo swims around his prey, he emits certain effluvia, like darts*, that first affect the water, and then the fishes in it; which, being thus disabled from defending themselves, or escaping, are held as it were in bonds, or frozen up.

From ÆLIAN, who writes a History of Animals, we might expect more information on this subject than from any other author; but we are much disappointed. He has been satisfied with reciting a few of the common reports, and adding others, too absurd to deserve repetition. It is remarkable, that these two professed writers of natural history, PLINY and ÆLIAN, should of all the ancients give us the lamest and most fabulous accounts of this subject of our inquiry.

Passing from the philosophers to the physicians, we shall receive little more satisfaction. Before the days of GALEN the torpedo was applied alive to parts affected, and particularly for the cure of an obstinate head-ach, as appears from SCRIBONIUS LARGUS, who lived under CLAUDIUS, and from DIOSCORIDES, who flourished soon after. But GALEN, always reasoning, and opposing empirical practice, assigns a cause for that salutary ef-

* Gr. ὥσπερ βέλη διασπείρει ἀπορροαίς.

fect. His physiological system was in a great measure founded on the four *primary qualities*, cold, hot, wet, and dry. He conceived, therefore, that the torpedo acted by a frigorific principle; for as cold occasions a numbness in an animated body, so does the shock given by that fish. Such was the theory and reasoning of that age; yet, bad as they were, they prevailed in the schools of medicine upwards of a thousand years. GALEN was confirmed in his opinion, by seeing, as he himself testifies, that disorder removed by the touch of a living torpedo; which being of a cold nature, stupified or blunted the acute sense of pain. The followers of this medical chief improved upon their leader. A living torpedo not being always at hand, when a refrigerating medicine was indicated, the deficiency was supplied by preparing an oil from the dead animal, which they were assured must possess all the virtues of the living one. Upon this conceit we find PAULUS of Ægina, one of the ancients of the Galenic school, recommending this oil for tempering the hot humour of the gout, and for other ailments that required cooling applications.

Now, considering what little information we have received from the philosophers and physicians among the ancients, it will scarcely be expected, that we should find

more among their poets. Poetry, the creature of the imagination, can seldom avail itself of strict history for a subject, whether in the natural or political world. The historians of either can yet see but parts of a great system, and these, in appearance, often crooked and deformed, from not knowing how they are to tally and to be put together, to compose the fabric of the universe and the history of man. Such disjointed materials make therefore but indifferent themes for a bard, whose aim is to captivate the fancy with something beautiful and finished. In effect, OPPIAN has made no improvement in the history of the torpedo, though he contrived in his *Hali-eutica* to write an elegant description of it, without departing much from truth. He not only commemorates the more than poetical powers with which nature has endowed this fish; but distinguishes, like DIPHIUS, the parts where they peculiarly reside. These parts he calls λαγόνες (the sides) from which, as OPPIAN imagined, the animal had a faculty of darting upon other fishes certain substances, he terms κερκίδες, but whereof the meaning is obscure. To the former of these expressions CLAUDIAN undoubtedly alludes, in a line of those verses which he copies from OPPIAN, in celebrating the properties of the torpedo:

Sed

Sed latus armavit gelido natura venena.

But, as the Roman poet has nothing new of his own, I shall with him close the relations I have been able to find of this curious fish in the monuments of antiquity. We must confess them to be all unsatisfactory; and the more, as it does not appear, there has been one, GALEN excepted, of all the above mentioned ancient sages, who had ever seen a living torpedo, much less who had made experiments on it; and least of all who had dissected it. The result of their inquiries served for little more than a winter's tale. Such, I say, are the accounts that I have been able to collect from the ancients, concerning this *wonder of the deep*; omitting only such reports as seemed to be either superstitious or fabulous. But of both sorts, you may be assured, that in those days of credulity, so many were imposed on the world, that we are not to wonder, if there have been men of genius and learning, who, not taking the pains to make experiments themselves, or strictly to inquire into those made by others, have presumptuously treated the whole affair as a vulgar error.

With the fall of the Roman empire, the history of animals, imperfect as it was, with all other sound learning, sunk into the darkness of the times; nor did it emerge

before the sixteenth century, an æra ever memorable for the revival of science. Then lived and flourished BELON, RONDELET, SALVIANI, GESNER, and others, who not only restored what was anciently known in natural history, but greatly improved the subject. Yet experiments were still rare and feeble, till, in the next century, HARVEY appeared, and began to make them on birds and quadrupeds. Nor did that famous interpreter of nature finish his career, and close his eyes in death, before they beheld the rising state of this Society, and the *Accademia del Cimento*, our elder but short-lived sister, already formed. Some of the most eminent of that academy judging an inquiry into the truth of what had been recorded concerning the torpedo, to be an object worthy their attention, availed themselves of their vicinity to a sea stored with that sort of fish, to make the trials. REDI, one of the most liberal and enlightened geniuses of that age, began, and was afterwards assisted by BORELLI and STENO the Dane, his colleagues. Lastly LORENZINI, his scholar, engaged in the same pursuit, and published a curious treatise upon the subject.

REDI'S first step was by experiments to distinguish between the real properties of the torpedo, and such as had erroneously been ascribed to it, by the learned, as well

well as by the vulgar of former times. To this research he added the anatomy of the animal; so that REDI was also the first, who with any accuracy described those crooked substances, lying on each side of the spine near the head, which he considered as muscles (from thence named *musculi falcati*) that projected certain effluvia occasioning the sensation of numbness, more or less, as the animal was excited to put these organs into action. This hypothesis, of the transmission of effluvia, was immediately embraced by LORENZINI, and afterwards by CLAUDE PERRAULT. But the former, not understanding how effluvia could pass from the body of one animal into that of another, without immediate contact, contradicted, we may say, the evidence of his senses, by denying the sensation he must have had upon touching the torpedo with a stick, a spear, or the like instrument; unless we should suppose those subjects, on which he made his trials, were too weak for exerting the full energy of their species.

From the like causes also erred the excellent BORELLI. But his theory not admitting the emission of benumbing particles, affecting the hand, either in immediate contact with the fish, or touching it with a stick, or the like, he referred the sensation to a certain brisk undulation of the parts touched, which the animal could excite

at

at will. This action he compared to that of a stretched cord put into quick vibrations.

Into a similar deception, in the next generation, fell that ornament of his country and of his age, the excellent M. DE REAUMUR, upon resuming this subject. For in the year 1714, being on the coast of Poitou, he took that opportunity of making some new experiments upon the torpedo, which, with the result, he communicated to the R. Academy of Sciences at Paris. His brethren of that illustrious society adopted his hypothesis, as did indeed the Ingenious over all Europe; and so natural did it appear to them, that every one wondered it had not been fallen upon before. What then was this new system? In effect, one not very different from that of BORELLI; for, instead of the undefined vibrating parts of the latter, M. DE REAUMUR substituted muscles (the *musculi falcati* of REDI and LORENZINI) which, by the vivacity of their action, impressed on the hand, that touched these parts, a sensation of numbness, owing to the stoppage of the progression of the nervous fluid, or a repulsion of the same. But, to obviate what might be objected, the celebrated investigator was bound to deny that this impression of numbness could be communicated through water, a net, or any other soft and yielding substance; nay, through

through a stick, except a very short one. In fact, M. DE REAUMUR did deny such transmissions; and yet it is certain, that the shocks from the torpedo are not less conducted through such *media*, than those from a charged electrical phial. Shall we then accuse of want of candour those celebrated authors, BORELLI, LORENZINI, and M. DE REAUMUR? By no means: but let us lament the weakness of the human intellect, which, pre-possessed by system, will often not perceive such objects as would strike the senses of any other person, nay most certainly their own, in a more unprejudiced state of mind! And let us regret that other infirmity, so incident to the best understanding, the too great forwardness to account for every appearance in nature, from such principles as are known, without considering how many yet remain to be discovered! There was a time, and that within the memory of many of my hearers, when thunder and lightning were thought sufficiently accounted for, from sulphureous and nitrous vapours mixing with the air. At present we doubt of the existence of such vapours in the atmosphere, and are otherwise sure, that the electrical fluid only is concerned in the formation of that meteor. Now it seems this very fluid is the efficient cause of the amazing qualities

lities of the torpedo. Nothing could be more unexpected, yet perhaps nothing more true.

The discovery of the Leyden phial opened a wide and rich field for the advancement of philosophy; and to the honour of this society it will ever be remembered, how much they have availed themselves of that fortunate accident, for interpreting some of the more intricate phenomena of nature. A few years after that memorable event, the celebrated professor ALLAMAND, fellow of this society, hearing of a fish, in the Dutch settlement of Surinam, resembling a congre eel, but with properties similar to those of the torpedo, engaged his friend M. 's GRAVESANDE, governor of Essequibo, to make the inquiry. That gentleman readily complied, and in the year 1754 wrote M. ALLAMAND a letter on the subject, which was soon after published in the second volume of the Transactions of the Society at Harlem. M. 's GRAVESANDE says, that the experiment was made on a species of eel, the Dutch call *sidder-vis* (*tremble-fish*) and that it produced the same effects with electricity, with which he had been well acquainted, by having with his learned correspondent made many experiments with the electrical phial; nay, that the shocks from the fish were much more violent, if it happened to be strong and lively of its kind;

kind; for then it would infallibly throw the person who touched it to the ground. But M. 's GRAVESANDE adds, that such exertions in this animal were accompanied with no sparks of fire, as in an electrical machine. Thus far I have abridged M. 's GRAVESANDE's letter. M. ALLAMAND subjoins, that he was satisfied that this eel must be a species of the gymnotus of ARTEDI, and all our subsequent accounts have confirmed his opinion.

In the second part of the sixth volume of the same valuable work, we find, of the same animal, a more ample relation extracted from some letters of M. VANDER LOTT, dated from Rio Essequibo, 1761. This gentleman makes two species, the black and the reddish, though he acknowledges, that, excepting the difference of colour and degree of strength, they are not materially different. In most of the experiments with these animals, M. VANDER LOTT remarked a wonderful similitude between them and an electrical apparatus: nay, he observed, that the shock could be given to the finger of a person, held at some distance from the bubble of air, formed by this eel when it rises to the surface of the water in order to breathe; and he concluded, that at such times the electrical matter was discharged from its lungs. He mentions another characterizing circumstance; which is, that

C

though

though metals, in general, were conductors to its electrical fluid, yet some were found to be sensibly better than others for that purpose.

About the same time that M. 's GRAVESANDE made his discovery in America, M. ADANSON, an eminent French naturalist, met with the same, or a similar fish, in the river of Senegal in Africa. He takes notice, that this animal had little relation to any of the known inhabitants of the water. That its body was round, and without scales, like an eel, but much thicker in proportion to its length; that it was well known to the natives, and that the French called it *trembleur*, from the effects it produced; not so much a numbness, like that arising from the torpedo, as a very painful trembling in the limbs of those who touched it. He adds, that this effect did not sensibly differ from the shock given by the Leyden phial, which he had felt; and that it was communicated in the same manner by simple contact, or by the interposition of a stick, or an iron rod (five or six feet long) so as to force the person to drop which ever of them he had in his hand.

M. FERMIN, in his Natural History of Surinam, published at Amsterdam, in 1765, observes of a fish, which the Dutch there call *Beef-aal* (*tremble-eel*) that one cannot
touch

touch it with the hands, or even with a stick, without feeling a horrible numbness in the arms, up to the shoulders. And he farther relates, that making fourteen persons join each other by the hands, whilst he grasped the hand of the last with one of his, and with the other touched the eel with a stick, the whole number felt so violent a shock, that he could not prevail on them to repeat the experiment. This fish, I believe we may with probability say, was the same species of *gymnotus* described by M. 's GRAVESANDE and M. VANDER LOTT, though the author does not compare its operations to those of the electrical phial.

The earliest account, for a distinct one, that I have met with of this kind of eel, in that quarter of the world, is by M. RICHER, the astronomer, recorded by M. DU HAMEL, in his History of the R. Academy of Sciences, for the year 1677. In the island of Cayenne, where M. RICHER had made his observations, there is a fish, says M. DU HAMEL, not unlike a congre eel, which touched with the finger, or even with the end of a stick, affects the arm with a numbness, nay the head with a giddiness, and the eyes with a dimness of sight, which M. RICHER had himself felt upon making the experiment.

If any further evidence were wanting, to ascertain the electrical nature of this eel in those parts, I would recommend the perusal of the Essay on the Natural History of Guiana, by Dr. BANCROFT, member of this Society, where the reader will find several curious experiments made on this animal by that gentleman. But, as the book is in every body's hands, I shall only take notice, that the author confirms M. VANDER LOTT's account, of a shock from this animal being communicated through a considerable space of air; a circumstance to which we have nothing similar in the torpedo, though it be a common effect in an electrical discharge.

I shall not therefore, GENTLEMEN, take up more of your time, with offering you further accounts of these curious animals, given us by travellers, and the less, as I have met with no original ones, excepting the above, but what from either too much brevity, or manifest signs of inaccuracy, have left much doubt to what *genera* of fishes those electrical ones were to be referred. I should only except that eel which M. DE LA CONDAMINE describes in his voyage down the river of Amazons, that was most probably the true electrical gymnotus (so commonly found in the rivers of the adjacent country of Guiana) about which we have been just discoursing. Not so that fish

which Mr. MOORE found in an African lake near the Gambia; nor that other, which Mr. ATKINS saw in the river Sierra-leon, likewise in Africa. And it is pretty evident that the electrical fish mentioned and delineated, but scarcely described by NIEUHOF, as taken in some of the lakes of India, and called by the Dutch *meer-aal* (*lake-eel*) is no species of the gymnotus, at least if justly drawn, since we find there a long fin on the back of that creature, and none on its belly. No more should that fish, provided with torporific powers, which PISO found in Brazil, have any other relation to the gymnotus, since the author compares it in figure to a sole. Nor that other, of the same country, possessed of similar qualities, which PISO calls *Piraqué* (MARGRAF, *Puraqué*) if it at all resembled the figures given of it by these travellers and natural historians. I would pass the same judgement upon the Indian *congrus monstrosus* of BONTIUS. And I should hesitate about that eel, the subject of a Paper, communicated to this Society in the year 1680, by Dr. GALE, from the author Dr. BATEMAN, who had been twenty years a planter in Surinam. All that I would with any degree of certainty conclude, is that among fishes the electrical properties are not confined to that species of ray called the torpedo, nor to that species of gymnotus called the *gymnotus electricus*, but that nature has endowed

dowed with the same powers several other inhabitants of the waters, though hitherto imperfectly known.

Now, in justice to those authors who have first mentioned the electric gymnotus, and especially to those who have originally furnished a similitude between the properties of the torpedo and those of that electrical eel, and between the properties of both and those of the Leyden phial, I have thought proper to commemorate their names on this occasion; though after all, I have reason to believe that our worthy brother has taken the hint of making his experiments from none of them, but solely from what he had read concerning the torpedo in writers, who thought of nothing less than referring such powers in animals to an electrical origin; nay, who lived, many of them, long before the laws of electricity were known. Nor had the surprizing benumbing effects of the electric gymnotus ever been so narrowly observed, much less confronted with an electrical apparatus, as that we could with any precision say, how far nature had carried the analogy between the two.

To Mr. WALSH therefore we owe not only the first, but a numerous set of the best chosen experiments on the torpedo, for ascertaining its electrical nature, together with some correct and elegant drawings of the intire animal,

mal, and of some of its principal organs that appeared upon dissection. For this latter part of the disquisition, the Society, as well as Mr. WALSH, is much beholden to another member, Mr. JOHN HUNTER, who thereby has supplied us with an useful addition to the anatomical examination of the animal by REDI, STENO, and LORENZINI. And I may moreover acquaint you, that though Mr. WALSH has laid before us an account of his principal experiments, his occupations have not yet permitted him to enumerate every curious particular that occurred to him in the course of his research; as I can testify, from having been favoured with the perusal of the journal he had kept of all his transactions.

The very first experiment of Mr. WALSH discovered the electrical quality of that fluid in the torpedo (which had so long distinguished this fish) by his conveying it through the same conductors with electricity, such as metals, water, and animal fluids; and by intercepting it by the same non-conductors, namely glass and sealing wax. Nor in this circumstance only did the similitude between the electric and torpedinous fluids appear: one of the most brilliant of Mr. WALSH's discoveries was, that this animal not only could accumulate in one part a large quantity of electric matter, but was furnished with a certain organization disposed

posed in the manner of the Leyden phial. Thus while one surface of the electric part (suppose on the back) was charged with this matter, or, as it is called, was in a positive state, the other surface (that on the belly) was deprived of it, or was in a negative state; so that the equilibrium could be restored, by making a communication between the two surfaces, by water, the fluids of the human body, or metals. A man pressing upon one of these surfaces with one hand, could, with the other, by the mediation of his own fluids, make a circuit for the conveyance, and at the same instant receive a shock; viz. the same sensation that is impressed by the electric matter in passing through our arms and body, from the inside of a charged Leyden phial to its outward coating. We need but attend to the following experiment, which Mr. WALSH made at Rochelle in presence of the Academy there, to see how admirable this circuit is, and how similar to a common electrical one. A living torpedo was laid on a table, upon a wet napkin; round another table stood five persons insulated; and two brass wires, each thirteen feet long, were suspended from the ceiling by silken strings. One of the wires rested by one end on the wet napkin, the other end was immersed in a basin full of water, placed on a second table, on which stood four other basins,

sons, likewise full of water. The first person put a finger of one hand into the water in which the wire was immersed, and a finger of the other hand into the second, and so on successively till all the five persons communicated with one another by the water in the basons. In the last bason one end of the second wire was dipped, and with the other end Mr. WALSH touched the back of the torpedo, when the five persons felt a shock, differing in nothing from that of the Leyden experiment, except in being weaker. Mr. WALSH, who was not in the circle of conduction, felt nothing. This was several times successfully repeated, even with eight persons; and the experiment being related by M. DE SEIGNETTE, mayor of the city, and one of the secretaries of the Academy of Sciences of Rochelle, and published by him in the French Gazette, the account becomes the more authenticated. For though we place full confidence in the candour and veracity of our worthy brother, yet in the eyes of the public the evidence must be strengthened by the testimony of those, who, but for the sake of truth and science, were no wise interested in the matter. We are therefore the more obliged to Mr. WALSH for having made these experiments *not in a corner*, but I may say, before the world; and in that very country which gave birth to the

celebrated M. DE RÉAUMUR, whose reputation as a philosopher could not but suffer some diminution, in proportion to the credit gained at this time by the fortunate stranger. And indeed the whole behaviour of the learned academicians, first at Rochelle, and afterwards at Paris (when the experiments became known there) was such to their guest, as shewed them to be on this, as on other occasions, the true lovers of science, emulous not envious of the reputation of their neighbours.

But though no farther evidence be wanting to authenticate the experiments of Mr. WALSH, yet for the confirmation of the conclusions he draws from them, it is with pleasure that I can join the testimony of our learned and candid brother Dr. INGENHOUSZ, physician to their Imperial Majesties at Vienna, who, being in Italy, when he received a general account of Mr. WALSH's success, at my request repaired to Leghorn, to make some experiments himself upon the torpedo. How far they agreed with, and corroborated, those of Mr. WALSH, I need not mention, as you have so lately heard the doctor's letter to me on that subject.

Nor shall I return to enter into any farther detail of Mr. WALSH's experiments, considering what encroachment I have already made on your time, and how sensi-

ble you must be, that those which I have already reminded you of, have merited the honours you are now conferring upon him. I shall only observe, that our ingenious brother, having traced the similitude between the operations of the torpedo, and those of an electrical apparatus, he found it so strong, as to persuade him that it was the identical fluid that actuated both the animal and the machine. Yet he remarks, that though the charged phial occasions attraction and repulsion in such light bodies as the pith-balls, placed near it, and its discharge is obtained through a space of air, and accompanied with light and sound; nothing of this occurs with respect to the torpedo. But to these objections against a perfect agreement between the electrical and torpedinous fluids, Mr. WALSH answers, that upon charging a number of large jars with a small quantity of electric matter, and then discharging them, that matter will yield the appearances of the torpedo only. It will not now pass the hundredth part of that inch of air, which in its collected state it would run through with ease; the spark and snap and the attraction and repulsion of the balls will also be wanting; nor will a point brought however near, if not just in contact, be able to draw off the charge; and yet this diffused electric matter, to effect its equilibrium, will instantaneously pass

through a considerable circuit of different conductors properly connected, and give a sensible shock to such persons as compose the circle. But where is that large surface of diffused electricity to be found in the torpedo? Mr. WALSH replies, that from a minute division of parts a large surface will arise; and that even our naked eye will tell us, that those singular tubulated organs of the torpedo consist, like our electric batteries, of many bodies of a prismatic form, whose surfaces taken together compose a considerable area. To this argument we may add, that hitherto no difference has been found, except with regard to more and less, between the electric matter which is drawn from the clouds, and that other which pervades all terrestrial bodies, and is collected by every apparatus. If therefore between lightning itself and the charge of a Leyden phial, there is no specific difference, nay scarce a variety, as far as is known, why then should we unnecessarily multiply species, and suppose the torpedo provided with one different from that which is every where else to be found? But leaving this question to be more thoroughly handled by subsequent experiments, let us conclude, that such has been the similitude established between the electrical fluid of the torpedo, and that of nature at large, that in a physical sense they may be considered as precisely the same.

Mr.

Mr. HUNTER has well observed, and I think is the first who has made the observation, that the magnitude and number of the nerves bestowed on these electric organs, in proportion to their size, must appear as extraordinary as their effects; and that, if we except the important organs of our senses, there is no part even of the most perfect animal which for its size is more liberally supplied with nerves; nor yet do these nerves of the electric organs seem necessary for any sensation that can belong to them. And with respect to action, he observes, that there is no part of any animal, however strong and constant its action may be, which enjoys so large a proportion of them. If then it be probable, that these nerves are unnecessary for the purpose either of sensation or action, may we not conclude, that they are subservient to the formation, collection, and management of the electrical fluid, especially as it appears from Mr. WALSH's experiments, that the will of the animal commands the electric powers of its body?

If these reflections be just, we may with some probability foretell, that no discovery of consequence will ever be made by future physiologists, concerning the nature of the nervous fluid, without acknowledging the lights they have borrowed from the experiments of Mr. WALSH upon

upon the living torpedo, and the dissection of the dead animal by Mr. HUNTER. But whether this will be the individual effect or not, philosophy by these curious and successful researches has made a valuable acquisition; since we may be assured, that whatever tends to disclose the *cause rerum*, the secret laws of Nature, cannot ultimately fail of subjecting her, more or less, to the uses of life; and of manifesting, more and more, the wisdom and power of the Creator in all his works.

MR. WALSH,

IN consequence of the approbation of the choice made by the Council, so unfeignedly expressed in the countenance of every gentleman present, it remains, that in the name, and by the authority, of the ROYAL SOCIETY OF LONDON, formed for the improvement of Natural Knowledge, I deliver into your hand this Medal, the prize you have so meritoriously obtained; not doubting, SIR, of your grateful acceptance of so honourable and unperishing a memorial of their esteem, and of the sense of their obligations to a person, who in so distinguished a manner has contributed to promote the great ends of their institution. And, in the same respectable name, let me
add,

add, that they are so much persuaded of your abilities to assist in their grand work, the *Interpretation of Nature*, that they earnestly call upon you to continue your liberal and spirited labours. With pleasure they understand that you have already turned your views to the electric gymnotus, that other wonder of the waters, an animal possessed of powers similar to those of the torpedo, but of superior energy; and the Society flatter themselves, that so much light will be gained by that inquiry, that you will be enabled soon to make a farther discovery of the mysteries of Nature. Her veil, fear not, SIR, to approach *. Animated with the presence of this illustrious and successful Body, I will venture to affirm, that Nature has no veil, but what time and persevering experiments may remove. In the instance before us, view the progress of the powers of the mind; view the philosophers of the early ages, like the "children of the World" †, amused and satisfied with the stories of the torpedo; as incurious about their authenticity, as about the causes of such extraordinary effects. This animal served them for an emblem, or an hieroglyphic, for a figure of speech, or an allusion of pleasantry; at best as a theme for a copy of verses. But

* Alluding to that passage in Mr. WALSH's Paper, "We here approach to that veil of Nature, which man cannot remove."

† Lord BACON.

the World, rising in years and in wisdom, rejects such trifles. The Interpreters of Nature, in the adult state of Time, make experiments and inductions, distrust their intellects, confide in facts and in their senses: and by these arts drawing aside the veil of Nature, find a mean and groveling animal armed with lightning, that awful and celestial fire, revered by the ancients as the peculiar attribute of the father of their gods.

ERRATA.

Page 10. line 18. for *sides* read *flanks*

21. 19. for Dr. BATEMAN read Mr. BATEMAN

E. F. A.



Page 10. No. 18. for the year 1885.
at the University of Toronto, 1885.

